Supporting information

Photovoltaic properties of the novel thiophene and selenophene based conjugated low bandgap polymer: A comparative study

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Fig. S1: ^{1}H NMR for P1 polymer.

Fig. S2: ^{1}H NMR for P2 polymer.

Fig. S3: Cyclic volatmmograms of polymers (a) P1 and (b) P2.

Fig. S4: J-V cures under an AM 1.5 G consition for P1 polymer blended in different ratios and coated at different spin speed.

Fig. S5: J-V cures under an AM 1.5 G consition for P2 polymer blended in different ratios and coated at different spin speed.

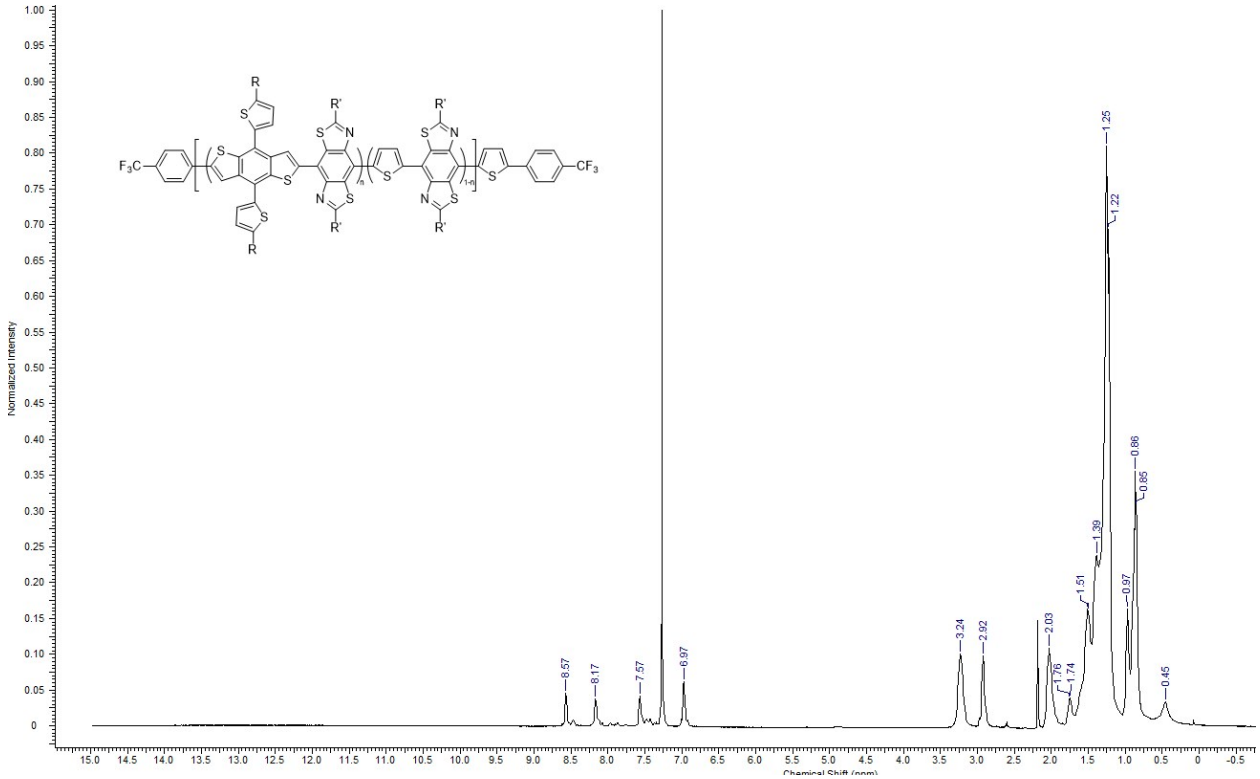
Normalized Intensity
Chemical Shift (ppm)
8.57
8.17
7.57
6.97
3.24
2.92
2.03
1.76
1.74
1.51
1.39
1.25
1.22
0.97
0.86
0.85
0.45

Fig. S1.

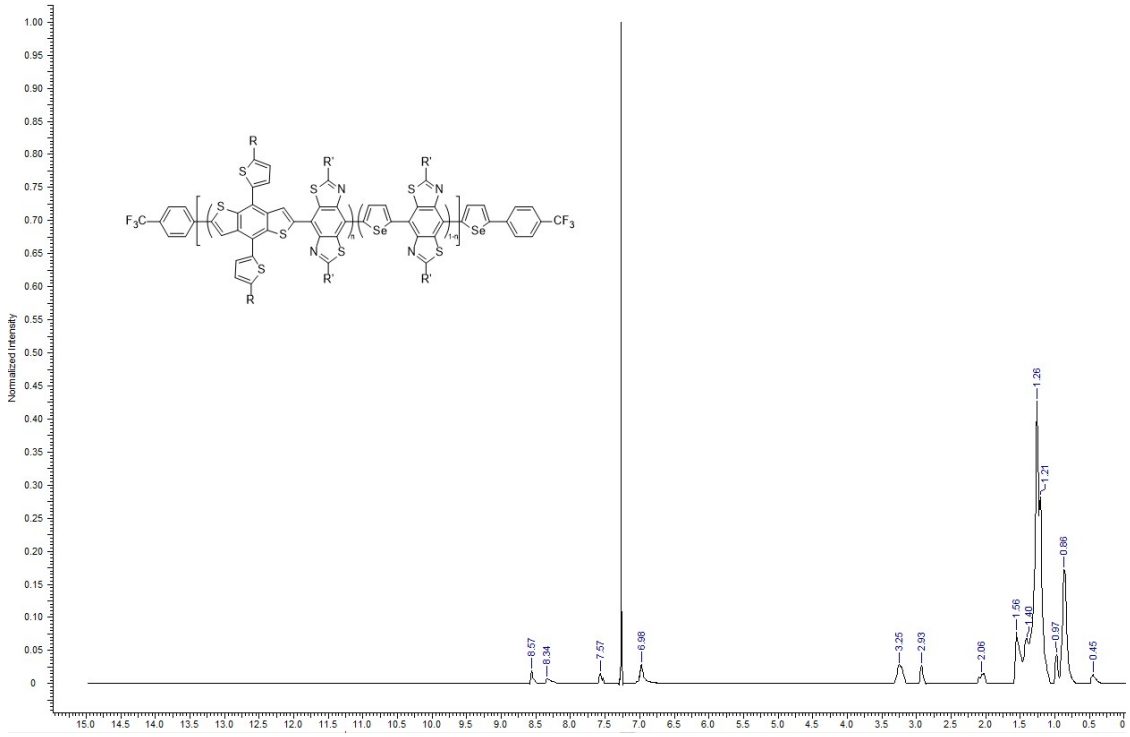
Normalized Intensity
8.57
8.34
7.57
6.98
3.25
2.93
2.06
1.56
1.40
1.26
1.21
0.97
0.86
0.45

Fig. S2

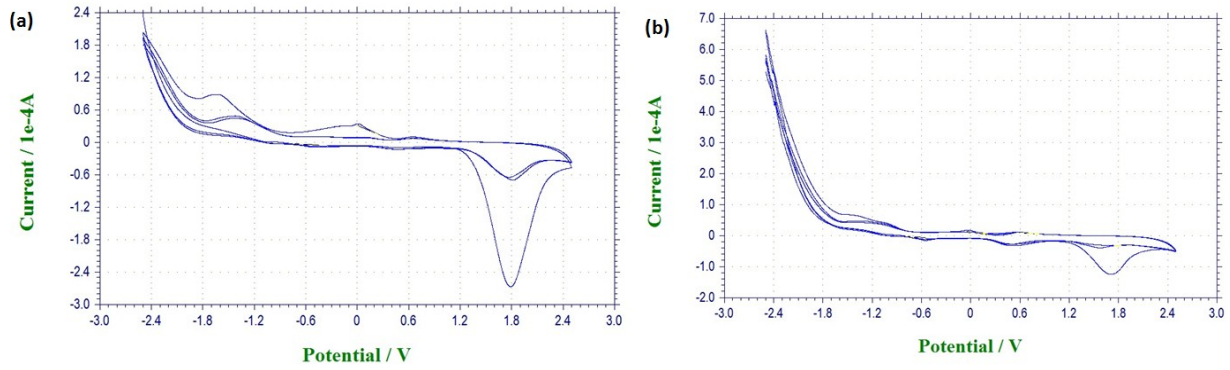
(a)
Current / 1e-4A
Potential / V
(b)
Current / 1e-4A
Potential / V

Fig.S3

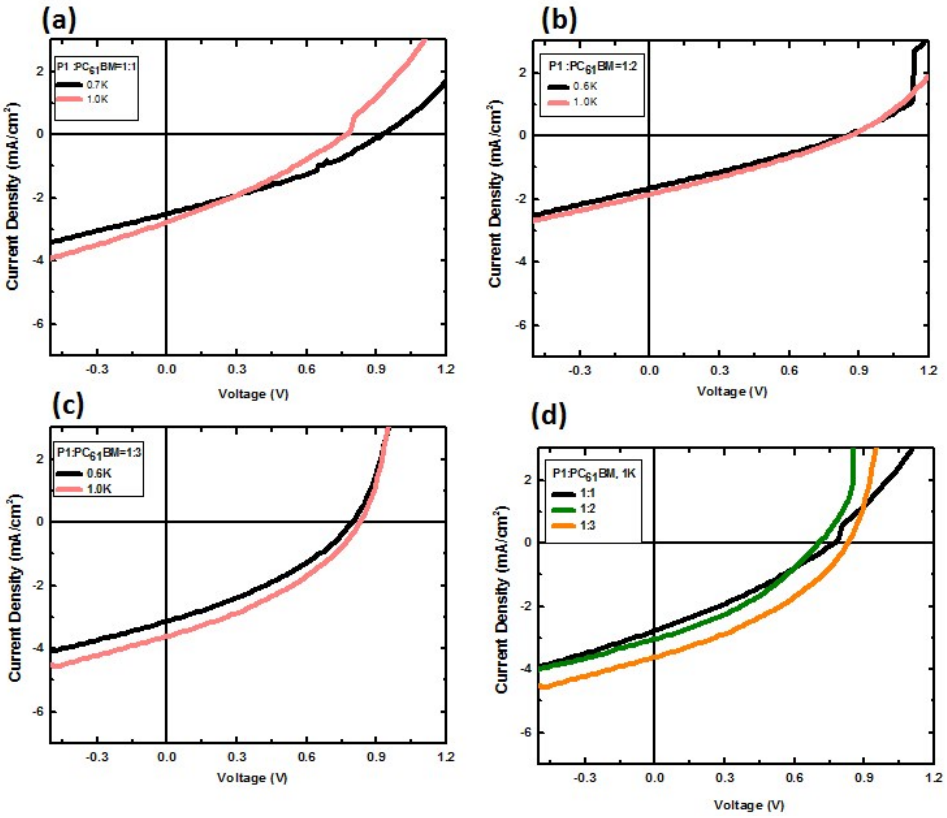
(a)
P1 :PC61BM=1:1
0.7K
1.0K
Current Density (mA/cm²)
Voltage (V)
(b)
P1 :PC61BM=1:2
0.6K
1.0K
Current Density (mA/cm²)
Voltage (V)
(c)
P1:PC61BM=1:3
0.6K
1.0K
Current Density (mA/cm²)
Voltage (V)
(d)
P1:PC61BM, 1K
1:1
1:2
1:3
Current Density (mA/cm²)
Voltage (V)

Fig. S4

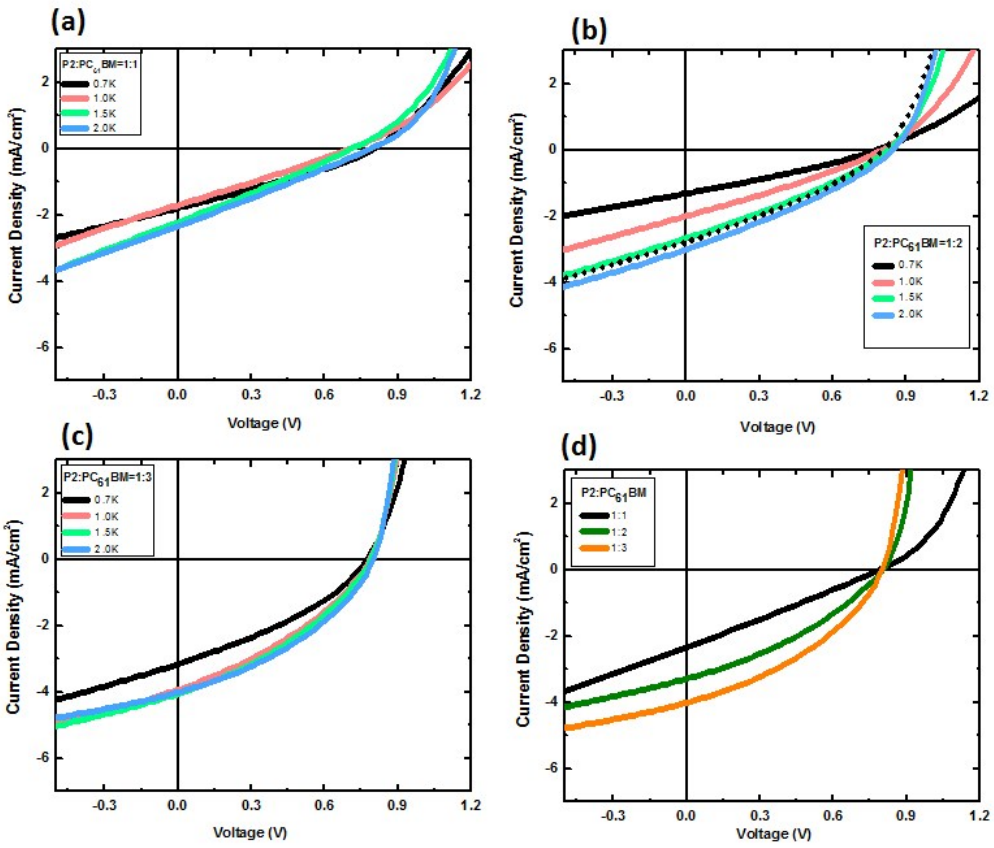
(a)
P2:PC61BM=1:1
0.7K
1.0K
1.5K
2.0K
Current Density (mA/cm²)
Voltage (V)
(b)
P2:PC61BM=1:2
0.7K
1.0K
1.5K
2.0K
Current Density (mA/cm²)
Voltage (V)
(c)
P2:PC61BM=1:3
0.7K
1.0K
1.5K
2.0K
Current Density (mA/cm²)
Voltage (V)
(d)
P2:PC61BM
1:1
1:2
1:3
Current Density (mA/cm²)
Voltage (V)

Fig. S5

Table S1: Photovoltaic properties of P1 polymer at various blended ratios and spin speed.

Active Layer	Spin-speed (rpm)	V_{oc} (V)	J_{sc} (mA/cm^2)	FF	η (%)	Average η (%)
1:1	600	0.797	2.648	0.329	0.69	0.71 ± 0.04
		0.828	2.446	0.338	0.68	
		0.923	2.511	0.330	0.77	
	1000	0.004	1.612			0.61 ± 0.03
		0.757	2.773	0.303	0.63	
		0.592	2.754	0.354	0.58	
		0.785	2.728	0.296	0.63	
		0.675	2.581	0.291	0.51	
1:2	600	0.884	1.537	0.282	0.38	0.37 ± 0.03
		0.726	1.566	0.286	0.33	
		0.837	1.666	0.279	0.39	
	1000	0.855	1.855	0.288	0.46	0.44 ± 0.02
		0.707	1.886	0.311	0.41	
		0.834	1.912	0.285	0.45	
		0.837	2.144	0.300	0.54	
		0.859	2.123	0.294	0.54	
1:3	600	0.680	3.055	0.350	0.73	0.77 ± 0.06
		0.635	3.050	0.377	0.73	
		0.791	3.142	0.343	0.85	
	1000	**0.823**	**3.612**	**0.362**	**1.08**	0.91 ± 0.14
		0.753	3.458	0.356	0.93	
		0.724	3.240	0.310	0.73	

Table S2: Photovoltaic properties of P2 polymer at various blended ratios and spin speed.

Active Layer	Spin-speed (rpm)	V_{oc} (V)	J_{sc} (mA/cm^2)	FF	η (%)	Average η (%)
1:1	700	0.670	1.762	0.305	0.36	0.38 ± 0.02
		0.799	1.793	0.287	0.41	
		0.718	1.783	0.280	0.36	
	1000	0.720	1.559	0.260	0.29	0.30 ± 0.01
		0.704	1.702	0.264	0.32	
		0.661	1.718	0.264	0.30	
	1500	0.799	2.028	0.259	0.42	0.40 ± 0.02
		0.710	2.212	0.266	0.42	
		0.690	2.030	0.263	0.37	
	2000	0.787	2.333	0.261	0.48	0.45 ± 0.04
		0.683	2.467	0.280	0.47	
		0.645	2.316	0.267	0.40	
1:2	700	0.740	1.249	0.292	0.27	0.28 ± 0.01
		0.774	1.313	0.291	0.30	
		0.762	1.254	0.289	0.28	
	1000	0.796	1.997	0.288	0.46	0.43 ± 0.03
		0.744	1.837	0.291	0.40	
		0.742	1.833	0.290	0.39	
	1500	0.282	2.319	0.296	0.19	0.46 ± 0.20
		0.819	2.669	0.301	0.66	
		0.769	2.339	0.292	0.53	
	2000	0.811	2.845	0.303	0.70	0.70 ± 0.06
		0.838	3.003	0.307	0.77	
		0.768	2.823	0.293	0.64	
1:3	700	0.769	3.161	0.343	0.84	0.79 ± 0.05
		0.586	3.285	0.373	0.72	
		0.756	3.241	0.335	0.82	
	1000	0.782	3.670	0.343	0.99	1.00 ± 0.04
		0.780	3.935	0.347	1.06	
		0.760	3.732	0.340	0.96	
	1500	0.785	4.049	0.356	1.13	1.07 ± 0.05
		0.707	4.071	0.369	1.06	
		0.756	4.020	0.336	1.02	
	2000	**0.795**	**4.014**	**0.379**	**1.21**	1.12 ± 0.07
		0.730	3.969	0.383	1.11	
		0.736	3.952	0.359	1.04	

Table S3: Influence of post thermal annealing (TA) at various temperatures on the PCE of polymer P2

Active Layer	Thermal Annealing (5min)	Spin-speed (rpm)	V_{oc} (V)	J_{sc} (mA/cm^2)	FF	η (%)	Average η(%)
1:3	60℃	2000	0.784	3.585	0.329	0.92	0.95
			0.785	3.830	0.334	1.00	± 0.06
			0.765	3.617	0.331	0.92	
1:1	85℃	2000	0.633	2.597	0.292	0.48	0.45
			0.579	2.687	0.284	0.44	± 0.02
			0.595	2.611	0.285	0.44	
1:2		2000	0.627	3.048	0.312	0.60	0.60
			0.642	3.158	0.306	0.62	± 0.02
			0.585	3.066	0.319	0.57	
1:3		2000	0.703	3.581	0.332	0.84	0.78
			0.631	3.519	0.324	0.72	± 0.06
1:3	100℃	2000	0.607	3.454	0.311	0.65	0.68
			0.599	3.458	0.349	0.72	± 0.03
			0.643	3.413	0.305	0.67	